INTERCONTINENTAL TRANSPORT OF AIR POLLUTION WITH GMI AND PLANS FOR THE NEW HEMISPHERIC TRANSPORT OF AIR POLLUTANTS (HTAP) MODEL INTERCOMPARISON STUDY

HARVARD UNIVERSITY
ATMOSPHERIC CHEMISTRY MODELING GROUP

**ROKJIN PARK, DANIEL J. JACOB, CAREY JANG,
SUSAN STRAHAN, JOSE M. RODRIGUEZ**

GMI meeting, October 12, 2006

UN-ECE LRTAP Task Force on Hemispheric Transport of Air Pollution (TF-HTAP)

Chairs: Terry Keating (EPA) and Andre Zuber (Eur. Commission)

CHARGE:

- develop a fuller understanding of the hemispheric transport of air pollution;
- estimate the hemispheric transport of specific air pollutants for the use in reviews of protocols to the LRTAP Convention;
- prepare technical reviews thereon for submission to the Steering Body of EMEP

First meeting: Brussels, Jun 1-3, 2005
Second meeting: Washington, DC, Jan 30-31, 2006
Third meeting: Beijing, China, Oct 18-20, 2006

T ... 9

Ke

1)

2) ... r

3)

4) How will changes in emissions in each of the other countries change pollutant concentrations?

5) How will these source-receptor relationships change due to changes in emissions in the future?

6) How will these source-receptor relationships be affected by changes in climate?

1st HTAP MODEL INTERCOMPARISON

•The fi … ptor
relatio … ors, PM,
and ot … due in
June 2 …

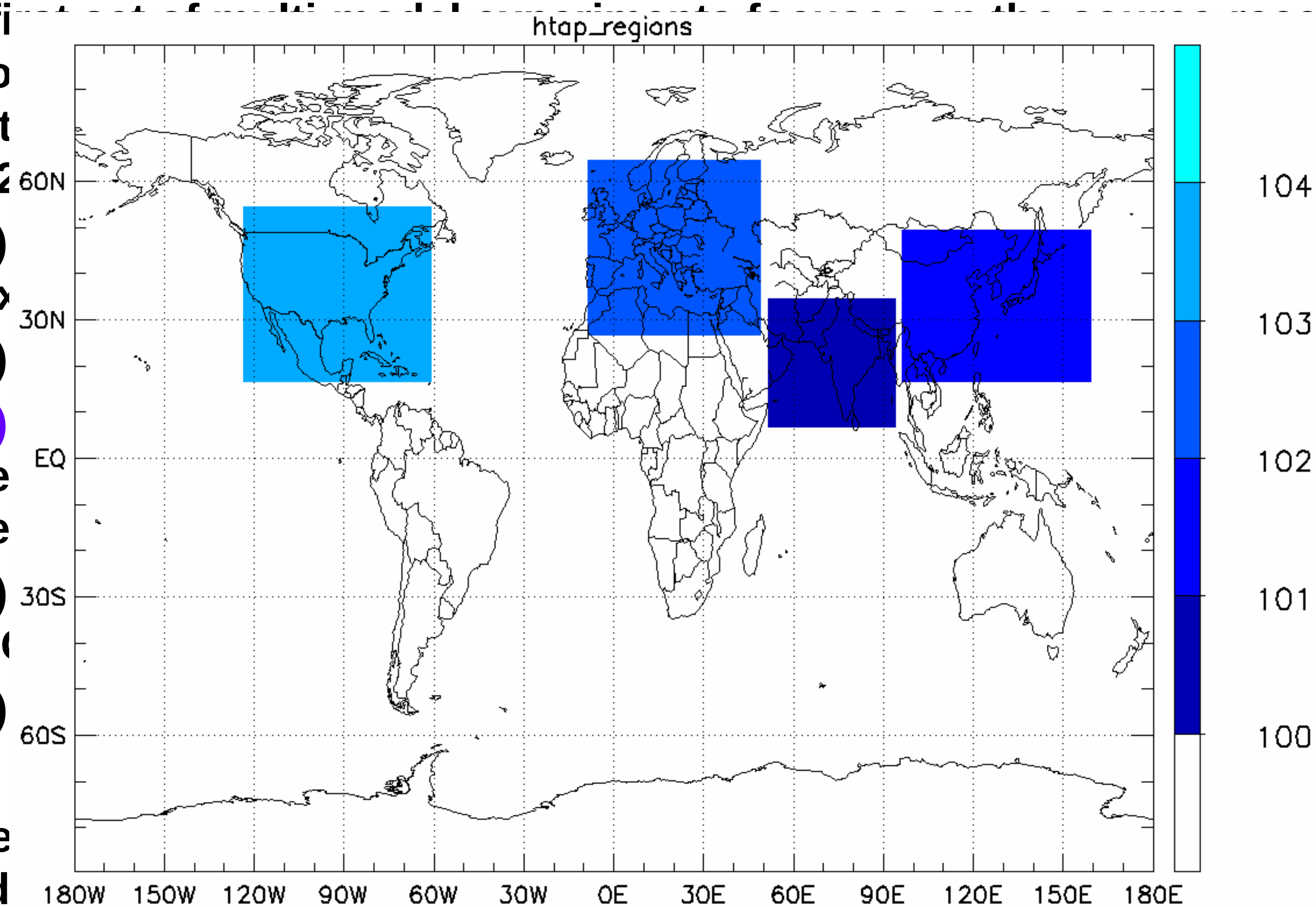
1) … ory and
fix …

2) …

3) …
re … ource
re …

4) …
N(…

5) … ions.



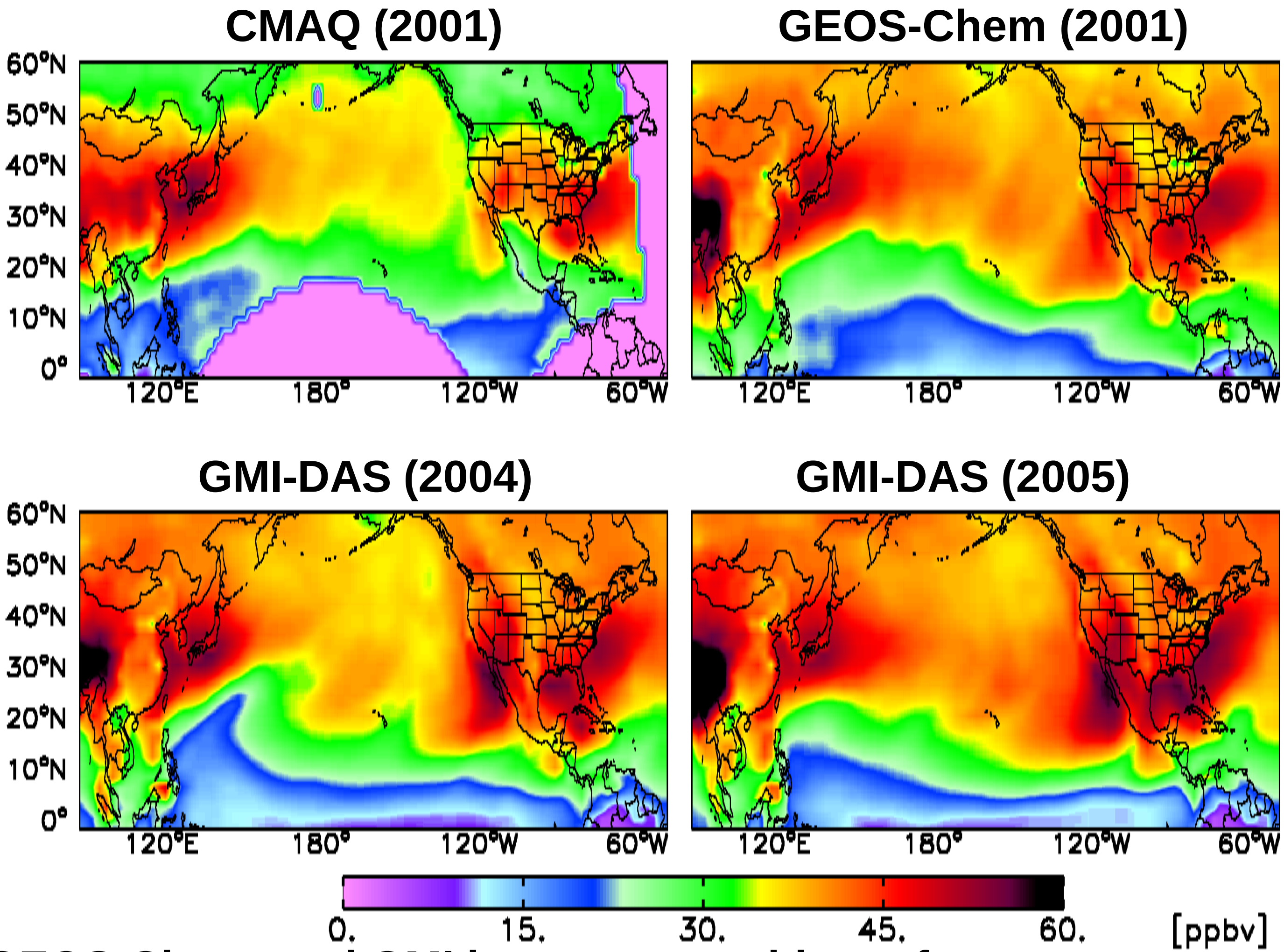
•Curre … in
includ …

•Detailed information is given at http://aqm.jrc.it/HTAP/.

PROPOSED LIST OF AUTHORS FOR 2007 TF HTAP INTERIM REPORT

Chapter	Coordinating Lead Authors	Lead Authors
0. Executive Summary	Terry Keating André Zuber	
1. Introduction	Terry Keating André Zuber	
2. Conceptual Overview	Owen Cooper Andreas Stohl	Ruth Doherty, Peringe Grennfelt
3. Observations	Hajime Akimoto David Parrish	
a. Surface Networks	Kjetil Torseth Joe Prospero	Shiro Hatakeyama, Rich Scheffe
b. Field Campaigns	Dan Jaffe Stuart Penkett	Russ Dickerson, Mat Evans
c. Satellite Observations	David Edwards Randall Martin	Lorraine Remer, Tony Hollingsworth, Ulrich Platt, John Burrows
4. Emissions & Projections	David Streets Zig Klimont	He Kebin, Imran Shahid, Toshimasa Ohara, John van Aardenne, Kristin Rypdal
5. Regional, Hemispheric, & Global Modeling	Frank Dentener Greg Carmichael	
a. Methods for Diagnosing or Quantifying Transport	Dick Derwent Michael Prather	Martin Schultz, Qinbin Li
b. Ozone	Arlene Fiore Oliver Wild	Hiroshi Tanimoto, Don Wuebbles, Carey Jang
c. Aerosols	Michael Schulz Rokjin Park	Peter Hess, Isabelle Bey, Dorothy Koch
6. Integration of Observations, Modeling, and Emissions Information	Len Barrie Daniel Jacob	Oystein Hov, Rudy Husar, Brendan Kelly, Jill Engel-Cox
7. Activities of the Task Force	Terry Keating André Zuber	
8. Synthesis, Conclusions, and Recommendations	Terry Keating André Zuber	All Coordinating Lead Authors

April SURFACE O_3 COMPARISONS: CMAQ vs. GEOS-Chem vs. GMI-DAS

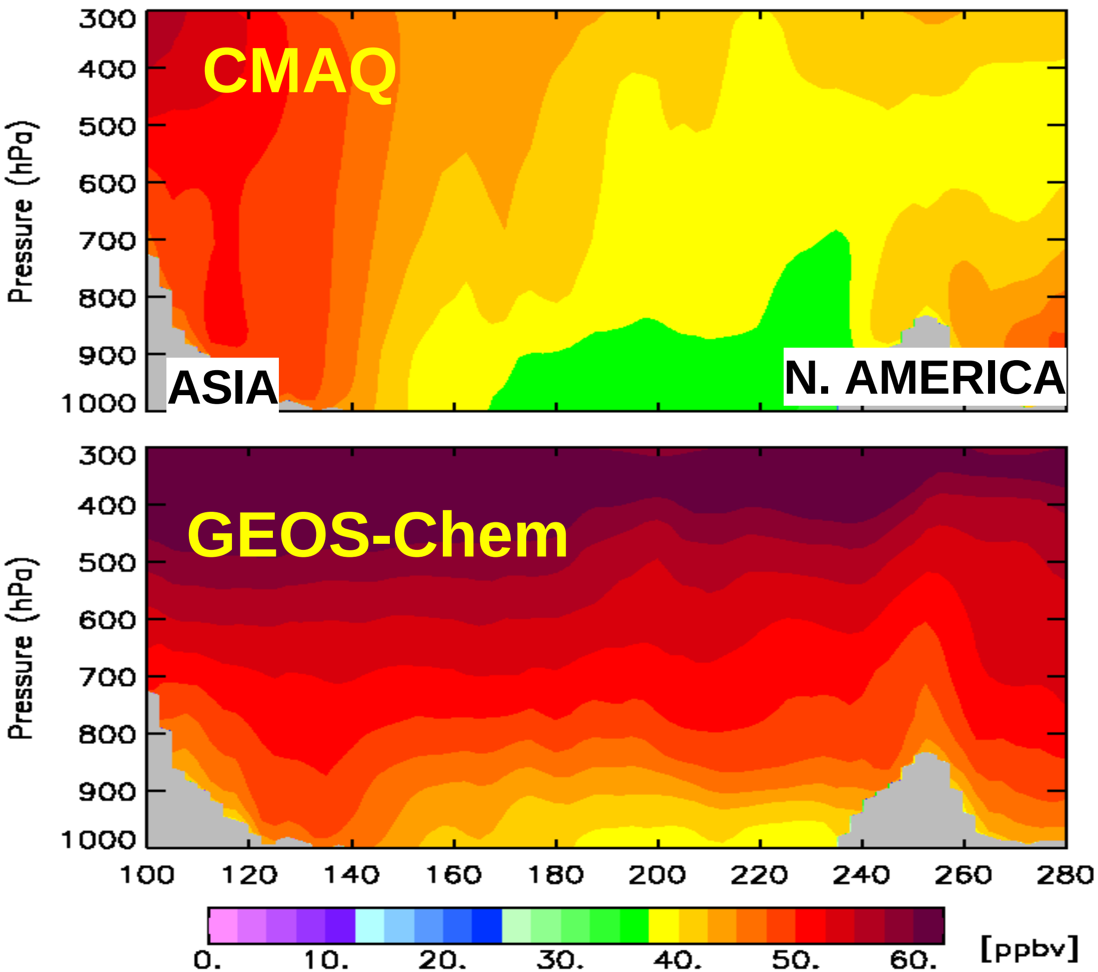


CMAQ, GEOS-Chem, and GMI have comparable surface ozone over continents but CMAQ is lower across Pacific. In the United States, GMI appears to be higher than GEOS-Chem.

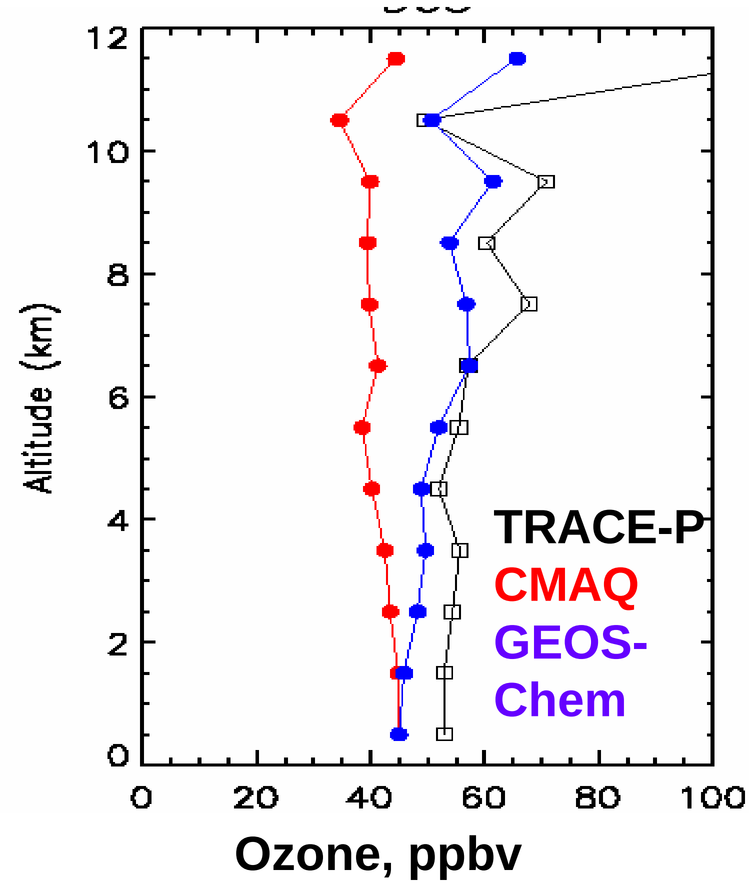
Rokjin Park (Harvard), Carey Jang (EPA/OAQPS), and Susan Strahan (NASA)

CMAQ vs. GEOS-Chem TROPOSPHERIC OZONE

Ozone concentrations at 25-50°N vs. pressure and longitude (April 2001)



Evaluation w/ mean TRACE-P obs in Asian outflow (<140E)



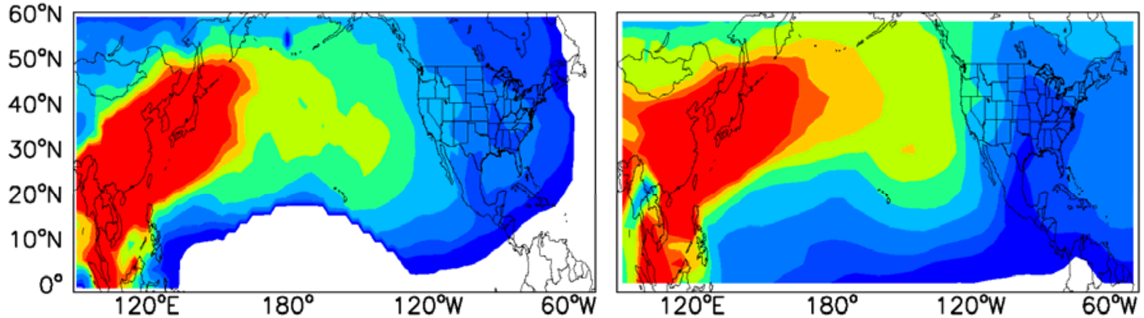
Low free tropospheric ozone in CMAQ likely due to processes usually neglected in regional models: STE, lightning, …

Rokjin Park (Harvard) and Carey Jang (EPA/OAQPS)

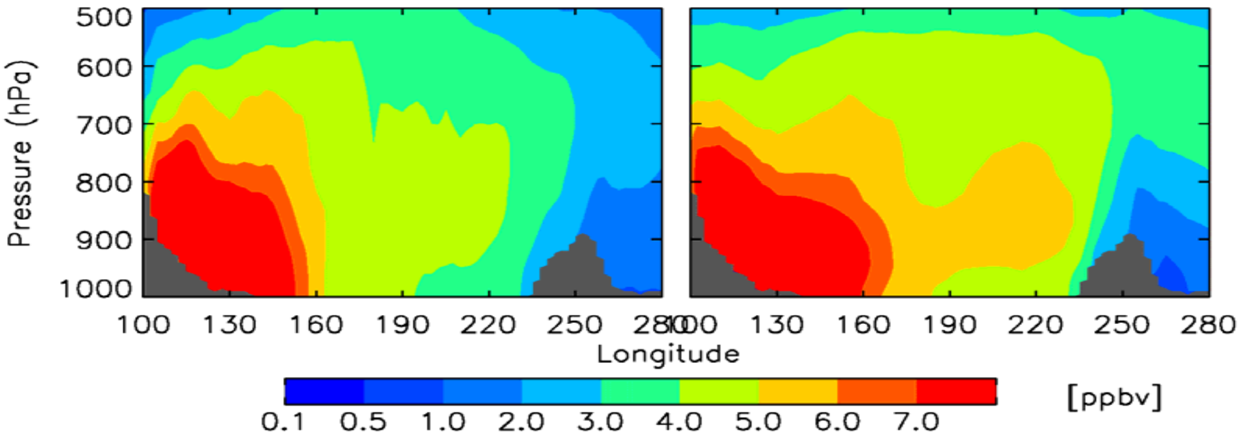
CMAQ vs. GEOS-Chem ASIAN POLLUTION ENHANCEMENT OF OZONE (April 2001)

CMAQ **GEOS-Chem**

ΔOzone in surface air

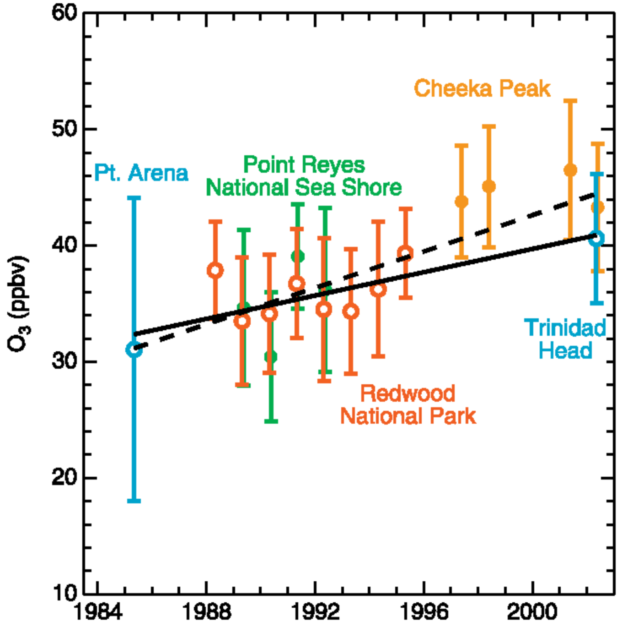


ΔOzone at 25-55 N vs. pressure and longitude



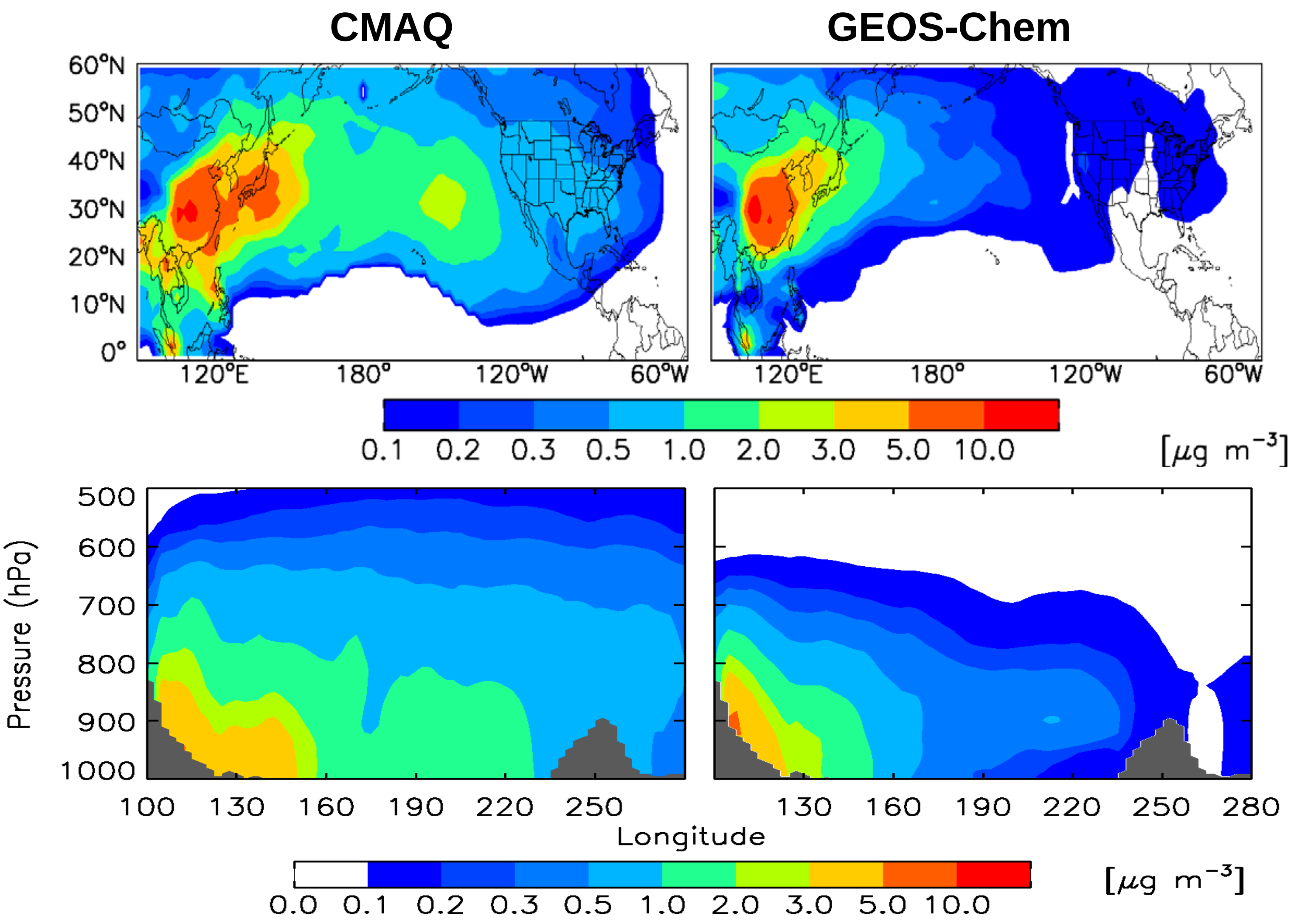
Ozone enhancement over the Pacific due to Asian pollution is lower in CMAQ than GEOS-Chem.

[Jaffe et al., 2003, GRL]



Springtime O_3 observed at the clean north western U.S. sites has increased by 10 ppbv over the past 20 years likely due to increases in Asian anthropogenic emissions [Jaffe et al., 2003]

CMAQ vs. GEOS-Chem ASIAN POLLUTION ENHANCEMENT OF SULFATE (April 2001)



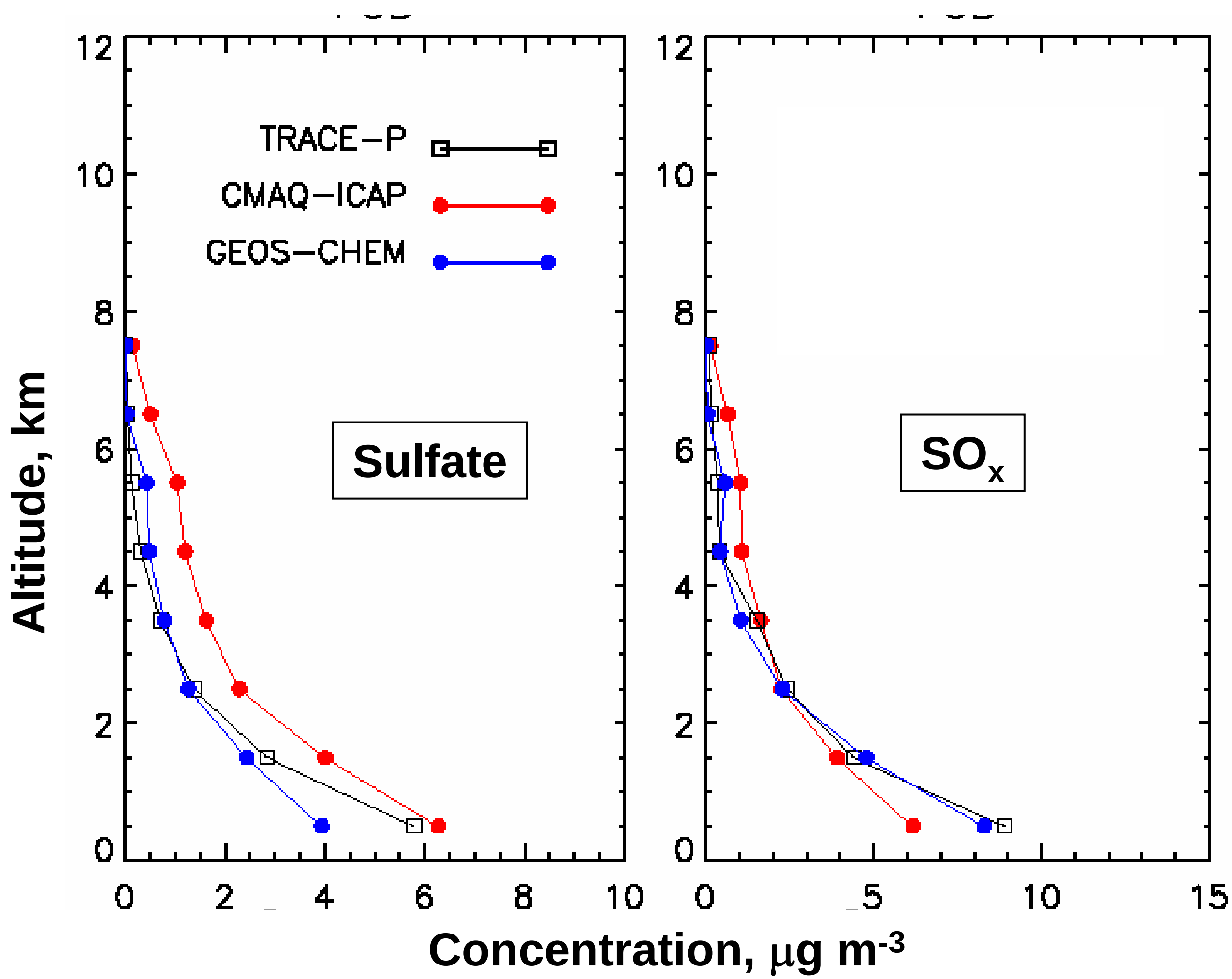
Δsulfate in surface air

Δsulfate at 25-55 N vs. pressure and longitude

Asian pollution influence in U.S. surface air in CMAQ is 5x that in GEOS-Chem

EVALUATING ASIAN SULFATE OUTFLOW:

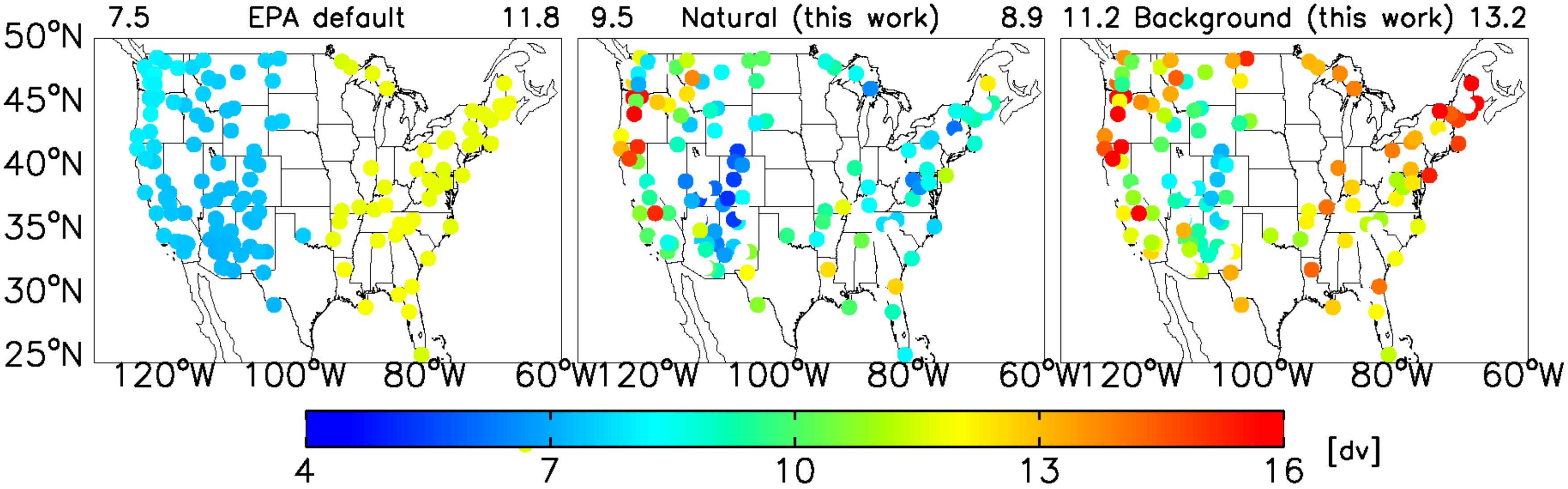
TRACE-P aircraft observations (Mar-Apr 2001, <140°E)



Suggests insufficient scavenging in CMAQ during venting to free troposphere

Rokjin Park (Harvard) and Carey Jang (EPA/OAQPS)

THE U.S. EPA REGIONAL HAZE RULE MANDATES VISIBILITY IMPROVEMENT AT LARGE NATIONAL PARKS TO NATURAL VISIBILITY CONDITION BY 2064



Background is defined by suppression of U.S. anthropogenic emissions but allowance for present-day foreign emissions and associated import of pollution

The schedule of emission reductions required in the 2004-2018 implementation period is very sensitive to the visibility endpoint by 2064

[Park et al., 2006]

PLAN FOR GMI SIMULATIONS

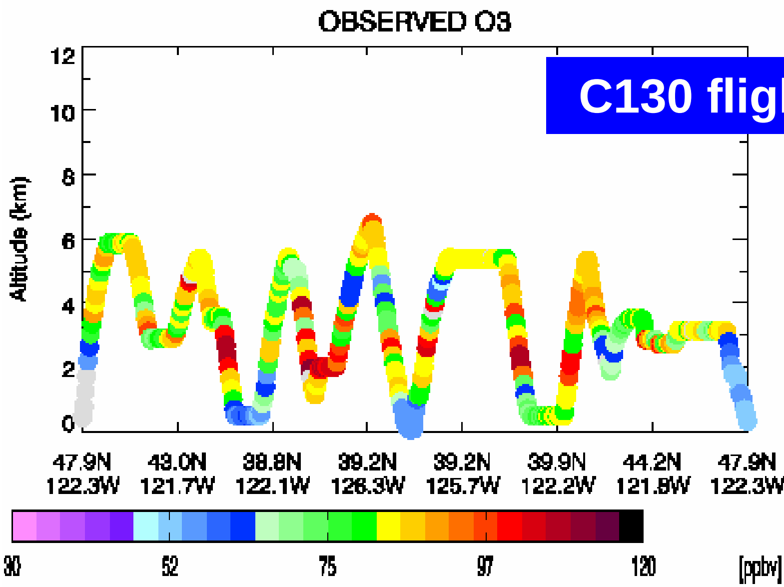
- For a given GMI coupled aerosol-chemistry tropospheric configuration, conduct several 1-year simulations with 2^ox2.5^o resolution for year 2001
  - Standard simulation to be submitted to HTAP as well as for comparison with GEOS-Chem, observations from TRACE-P, U.S. surface sites
  - Perturbed anthropogenic emissions following HTAP recommendations of 20% reduction in four source regions

- Conduct simulations with different GMI meteorological fields if available, same emissions and chemistry

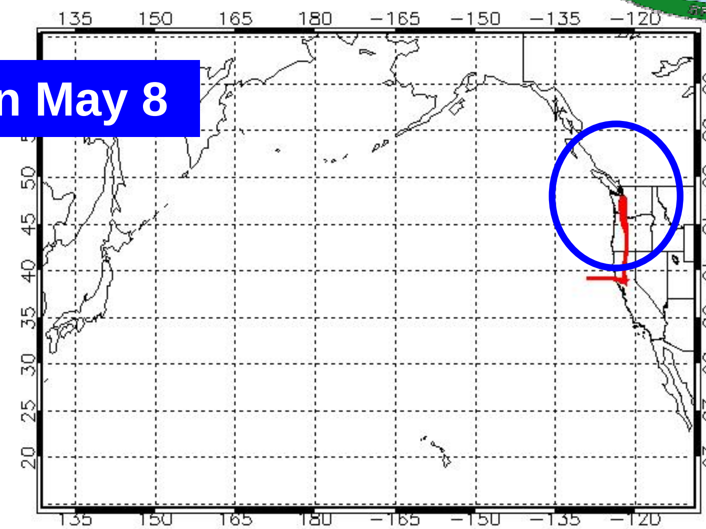
- Important results of this work will provide an assessment of intercontinental transport including characterization of errors due to differences in treatment of model transport, etc and will also be delivered to the 2007 interim and the 2009 final HTAP report

- Conduct GMI simulation for year 2006 to examine transpacific transport of ozone and aerosol together with observations from TES, INTEX-B

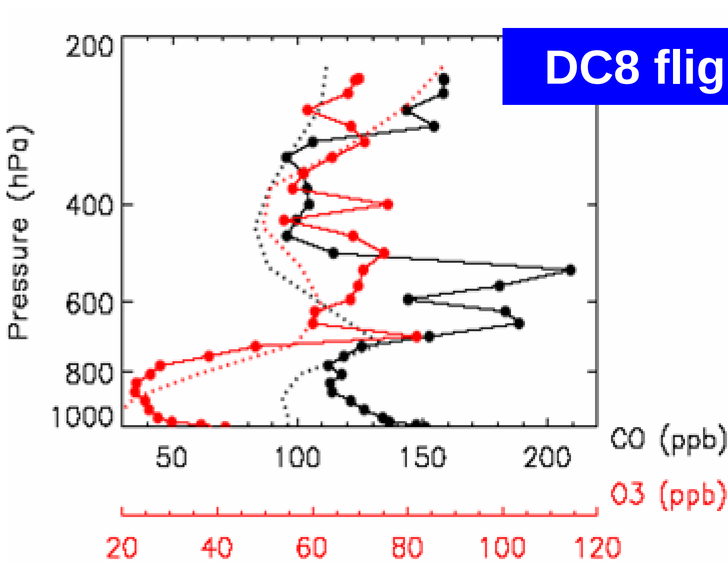
INTEX-B aircraft campaign in spring, 2006 observed transpacific pollution transport events

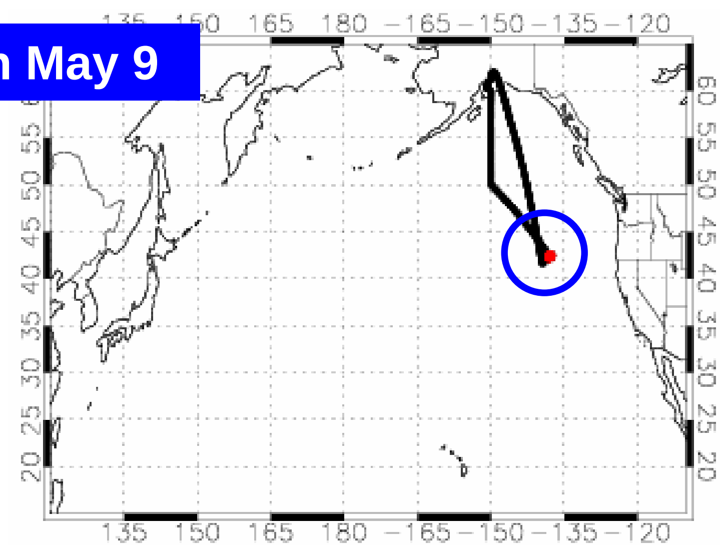


C130 flight on May 8



DC8 flight on May 9





Melody Avery and Glen Sachse [Nasa Langley]

Additional slides

UN-ECE LRTAP Task Force on Hemispheric Transport of Air Pollution (HTAP)

Chairs: Terry Keating (EPA) and Andre Zuber (Eur. Commission)

CHARGE:

- **develop a fuller understanding of the hemispheric transport of air pollution;**
- **estimate the hemispheric transport of specific air pollutants for the use in reviews of protocols to the LRTAP Convention;**
- **prepare technical reviews thereon for submission to the Steering Body of EMEP**

- First meeting: Brussels, Jun 1-3, 2005
- Second meeting: Washington, DC, Jan 30-31, 2006

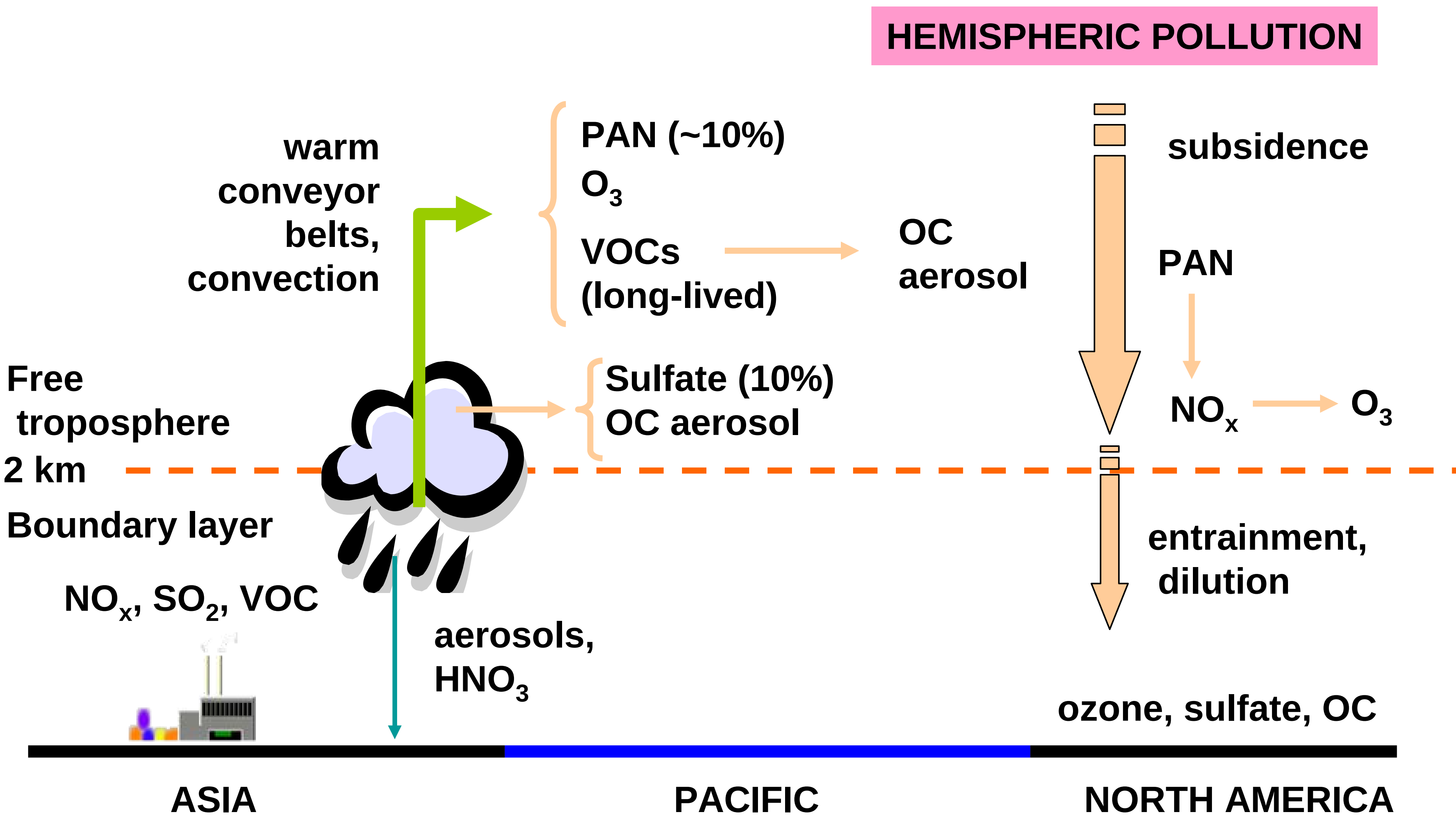
First meeting: Brussels, Jun 1-3, 2005

Second meeting: Washington, DC, Jan 30-31, 2006

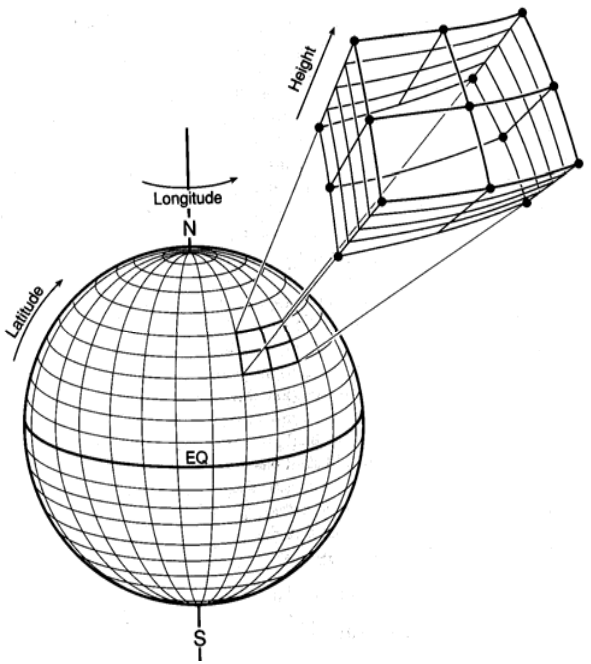
OBJECTIVES OF SECOND MEETING:

- **Define model metrics for intercontinental transport of pollution;**
- **Develop protocols for model intercomparisons**
- **Coordinate modeling efforts, data bases;**

MECHANISM FOR TRANSPACIFIC TRANSPORT OF ANTHROPOGENIC OZONE AND AEROSOLS



MODEL METRIC FOR INTERCONTINENTAL INFLUENCE



(1) Standard simulation; compare w/ observations

(2) Set N. American anthropogenic emissions to zero ➪ estimate background

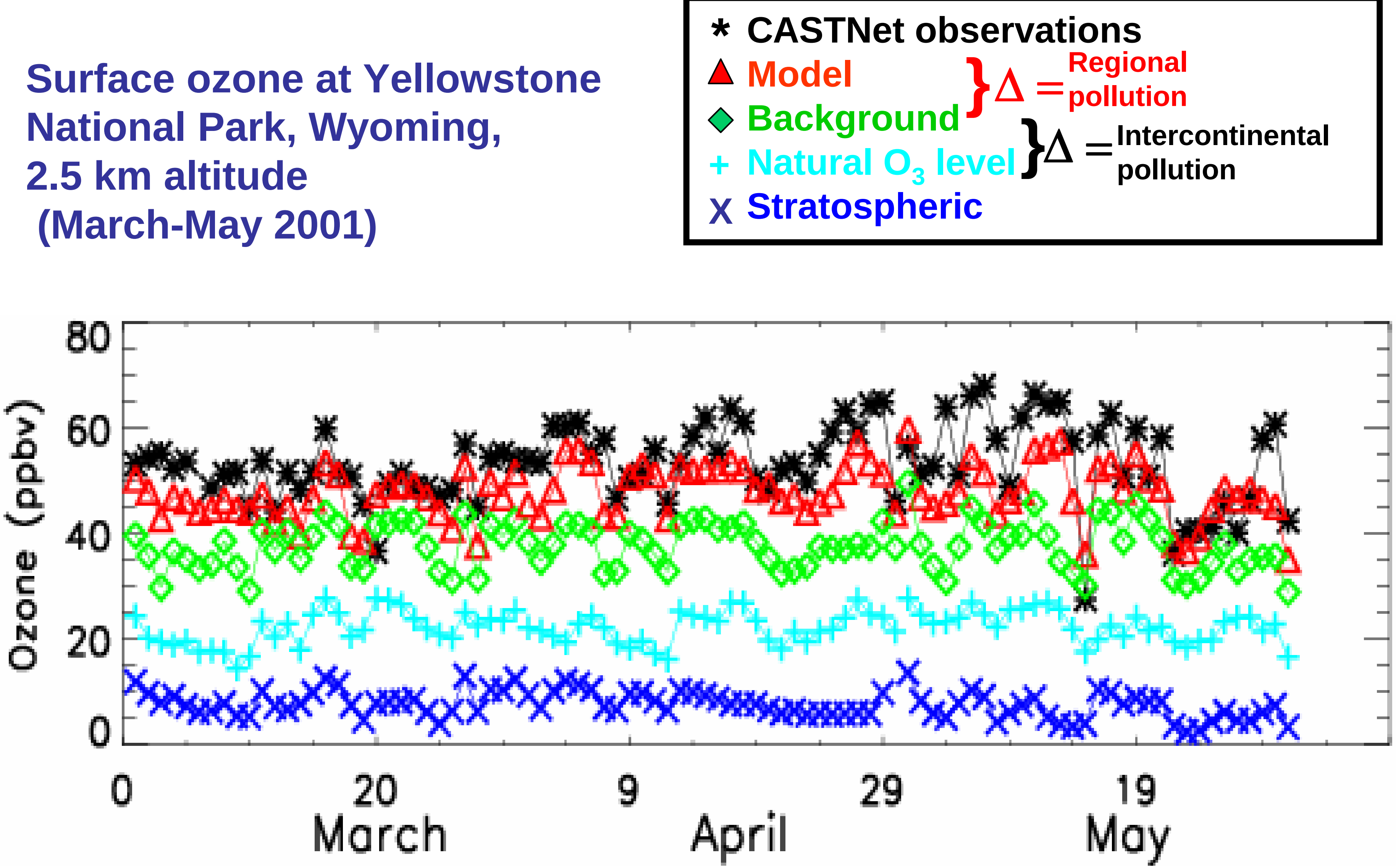
(3) Set global anthropogenic emissions to zero ➪ estimate natural background

Difference between (1) and (2) ➪ regional pollution

Difference between (2) and (3) ➪ intercontinental pollution

To avoid difficulty to interpret changes associated with complete reductions, HTAP intercomparison suggests to apply small perturbations (20%) to emissions from individual continents.

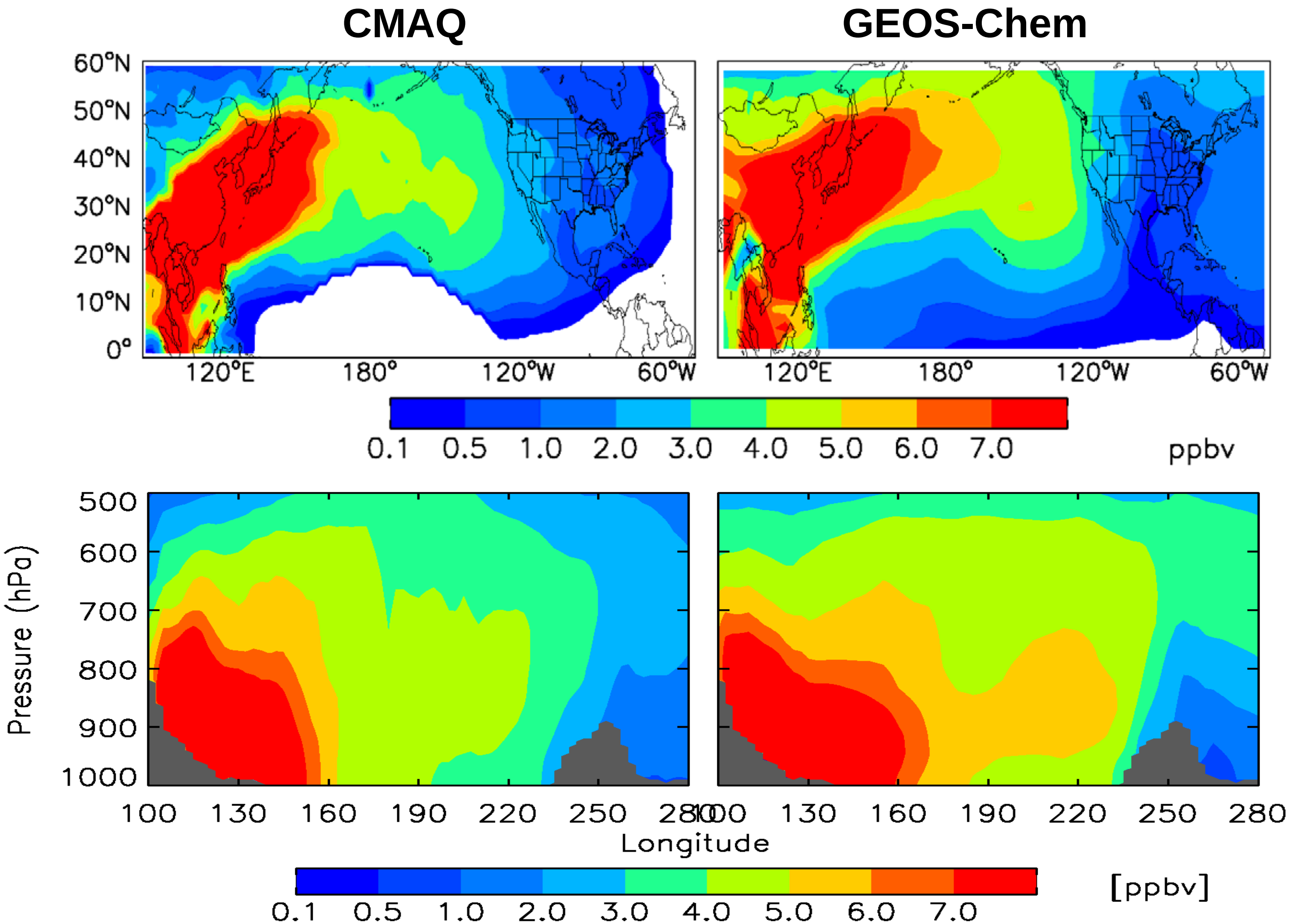
Surface ozone at Yellowstone National Park, Wyoming, 2.5 km altitude (March-May 2001)



Background: 30-50 ppbv
Natural : 15-30 ppbv

Fiore et al. [2003]

CMAQ vs. GEOS-Chem TRANSPACIFIC TRANSPORT OF OZONE (April 2001)



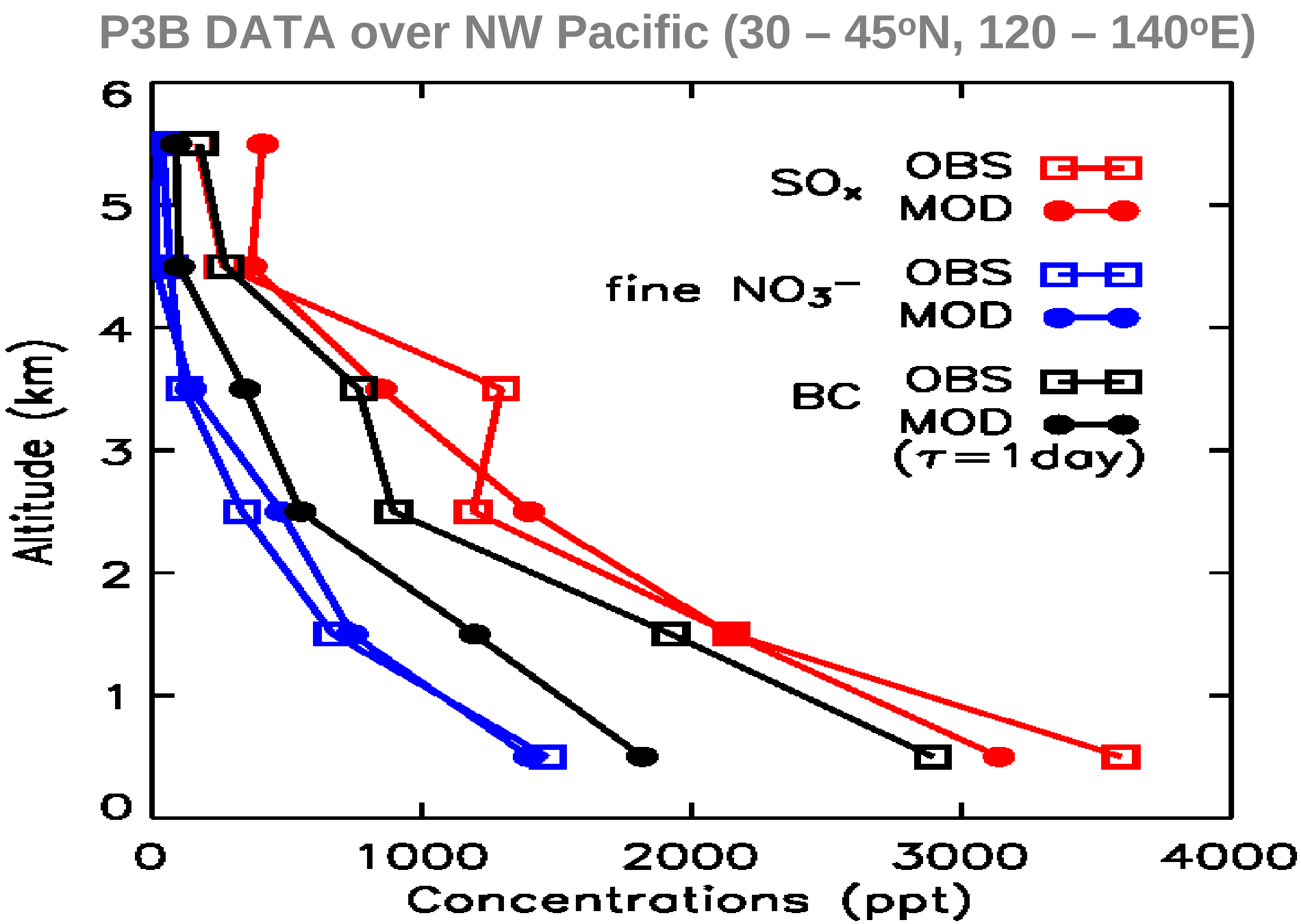
ΔOzone in surface air

ΔOzone at 25-55 N vs. pressure and longitude

Asian pollution influence in U.S. surface air in CMAQ is similar to that in GEOS-Cher

WET SCAVENGING OF ASIAN AEROSOLS DURING LIFTING TO THE FREE TROPOSPHERE

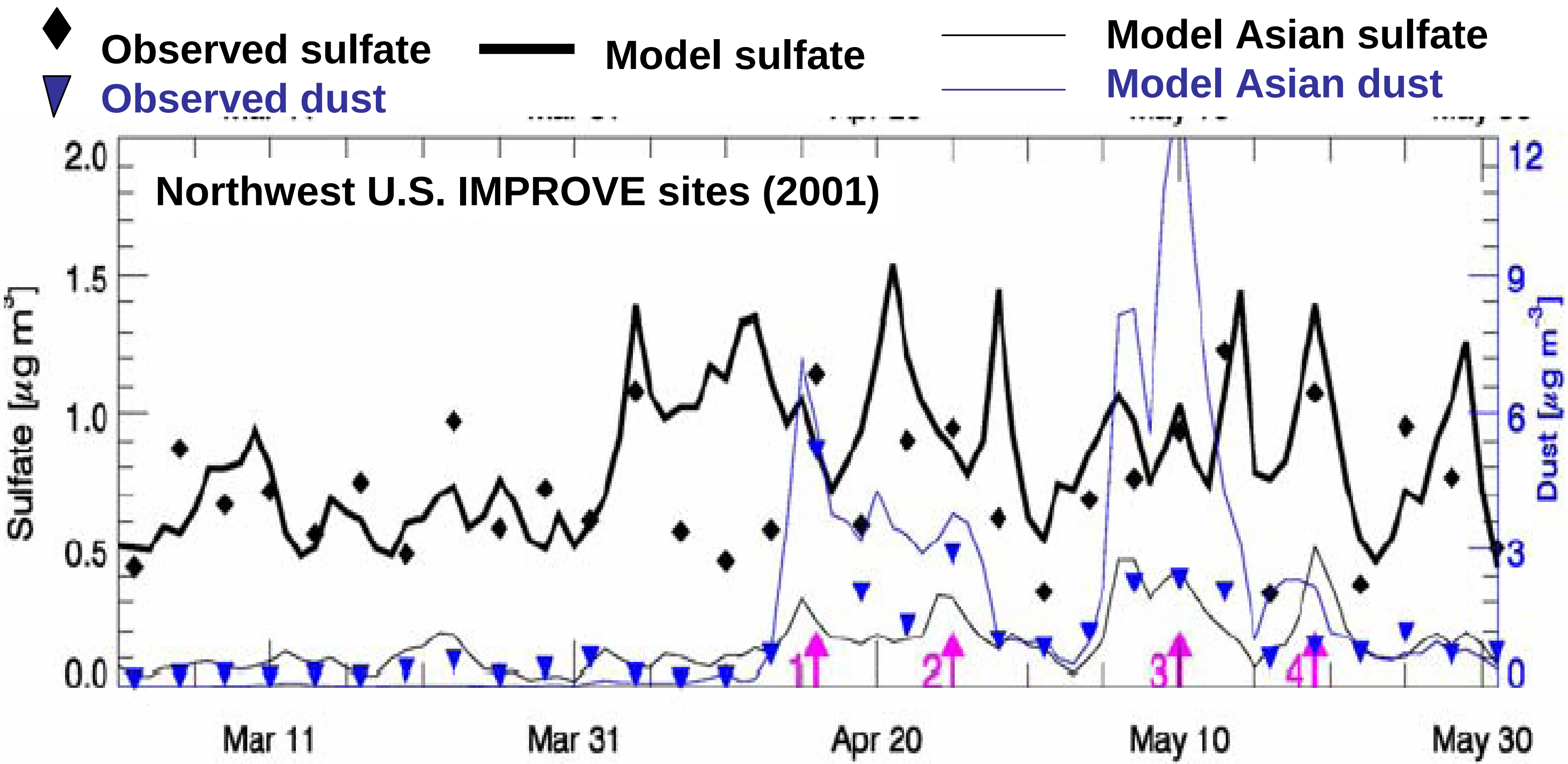
TRACE-P observations over NW Pacific (Feb-Mar 2001) and GEOS-Chem simulations



Sulfate is most importantly exported anthropogenic aerosol in model

Park et al. [2005]

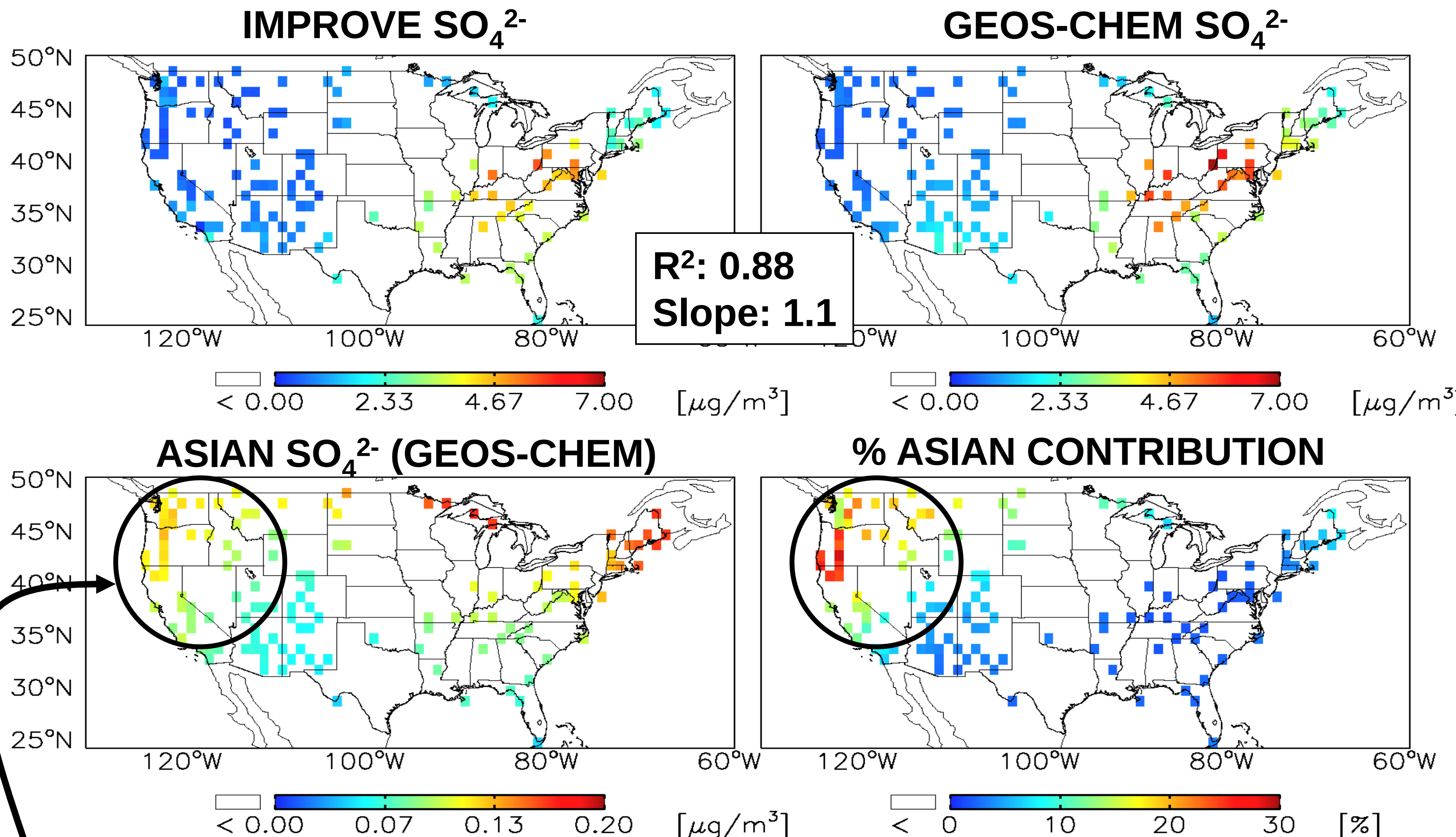
TESTING TRANSPACIFIC SULFATE IN GEOS-Chem WITH SURFACE OBSERVATIONS IN NORTHWEST U.S.



Mean Asian pollution enhancement in NW U.S. in spring: 0.16 ± 0.08 μg m^{-3}

Heald et al. [2006]

ASIAN POLLUTION CONTRIBUTION TO ANNUAL SULFATE CONCENTRATIONS IN SURFACE AIR (IMPROVE SITES)



ASIAN SO_4^{2-} CONTIRUBTIONS ARE COMPARABLE TO EPA NATURAL VALUES.